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Numerical study of stress-strain state of pelvis at the proximal femur rotation osteotomy

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Abstract

© Sachenkov O.A., Hasanov R.F., Andreev P.S., Konoplev Yu.G., 2016.The relevance of this study is dictated by the high frequency of occurrence of the disease. Among all hip diseases, Legg-Calvé-Perthes disease takes 25-30 % of diseases in childhood. There are no certain and founded recommendations for surgering in general and rotary flexion osteotomies in particular. The study is to determine the stress-strain state of the joint at different directions and magnitudes of the rotation angle. Calculations were carried out by using computer modelling of the hip joint based on localization of degenerative process and the severity of the degeneration of epiphysis in children and adolescents with Legg-Calvé-Perthes diseases. Numerical studies were performed using the finite element method in Nastran Siemens NX. The paper took into account the effect of the following muscles: mm. piriformis, rectus femoris, iliopsoas, obturatorius internus, gluteus minimus, medius et maximus. The calculations allow us to determine the forces produced in the muscles, reactive power and reactive torque acting in the joint at different rotation angles (these values are relevant for assessing the stiffness of external fixation device). The maximum shear stresses and Mises stresses have been identified in the acetabulum and the proximal part of the femur. Evaluation of strength was determined by the maximum shear stresses. So, in the acetabulum with a rotation of 25° forward and rotation of 35° back, the greatest value of maximum shear stress exceeds 1.7 MPa; at the rotation of more than 30° back, the value of similar stress exceeds 6.4 MPa; at forward rotation to 50°, the highest maximum shear stresses reach a value of 5.0 MPa. Thus, when the rotation back to the angle over 30°, maximum shear stresses in the joint region are into the lower critical value, at 35,° they are situated in the upper region of the critical values. When considering forward rotation angle over 25°, maximum shear stresses are into the lower region of the critical values, crossing through the upper region of the critical values at rotation to 50° does not occur.

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Keywords

Legg-Calvé-Perthes disease, Mathematical modelling, Rotary flexion osteotomy